The Association between Socioeconomic Disadvantage and Attention Deficit/Hyperactivity Disorder (ADHD): A Systematic Review

Running Head: SES and ADHD Systematic Review

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None

Abstract

This systematic review examines associations between parental socioeconomic disadvantage and childhood attention deficit/hyperactivity disorder (ADHD). Socioeconomic status (SES) was measured by parental income, education, occupation and marital status. Results were mixed by measure of SES with no one aspect being differentially related to ADHD. 42 studies were included in the review, of which 35 found a significant univariate association between socioeconomic disadvantage and ADHD. Meta-analyses of dimensions of SES and their association with ADHD indicate that children in families of low SES are on average 1.85-2.21 more likely to have ADHD than their peers in high SES families. In spite of substantial between-study heterogeneity, there is evidence for an association between socioeconomic disadvantage and risk of ADHD measured in different ways. This is likely mediated by factors linked to low SES such as parental mental health and maternal smoking during pregnancy.

Keywords: attention deficit/hyperactivity disorder, ADHD, socioeconomic disadvantage, socioeconomic status, SES, health inequalities

Abbreviations: ADHD: attention deficit/hyperactivity disorder. SES: socioeconomic status

Introduction

ADHD

Attention-deficit/hyperactivity disorder or hyperkinetic disorder (both referred to henceforth as ADHD) affects between 1 and 5% of children and adolescents worldwide [1]. ADHD is characterised by impairing levels of inattentive, hyperactive and impulsive behaviours that are both inappropriate for the child's age and are present across a range of settings [2]. ADHD is a debilitating and impairing condition for children [3] and is known to increase the risk of poor outcomes throughout stages of life [4-6]. The economic impact of ADHD is estimated to be substantial [7]. In addition, between 30 and 70% of those with a childhood diagnosis of ADHD will continue to experience clinically significant symptoms into adulthood [3].

Evidence suggests that ADHD is highly heritable; one figure calculated with data from 20 twin studies worldwide found the mean heritability of ADHD to be around 76%. However there is also evidence of an association between ADHD and low socio-economic status (SES). Biopsychosocial models of ADHD posit both genetic and environmental interactions leading to increased risk of ADHD, however it has become clear that there is no simple causal explanation [8]. In line with this complex aetiological picture of ADHD, researchers have examined a wide variety of potential and inter-related risk factors or causal mechanisms, some linked to low SES, including maternal smoking during pregnancy [9, 10], social adversity, severe early childhood deprivation [11, 12], home environment, parenting [13], diet [14], genetic predispositions or rare genetic events [15, 16] and more general measures of low parental socioeconomic status (SES) [17-19]. Several authors have noted an association between parental socioeconomic disadvantage (e.g. low parental income, manual occupation, poor education and not owning the family home [20] with an increased risk of ADHD [11,

17, 19, 21, 22]. Although this association is often reported in recent ADHD literature, there is a lack of systematic evaluation as to the size and nature of the association between socioeconomic disadvantage and an increased risk of ADHD. The impact ADHD has on children, families, schools and economies means it is necessary to examine potential preventative strategies. If there is indeed a strong association between ADHD and SES, this would imply that SES may lie on a causal pathway between ADHD genotype and phenotype, as recently suggested by quasi-experimental research [23] .

It is important to establish the strength of any association between ADHD and low SES as it has implications for the theory and mechanisms of ADHD aetiology. Furthermore, as discussed by authors in the field of health inequalities [24, 25], different facets of SES represent different underlying constructs e.g. income represents economic capital whereas education may reflect as a marker of human capital [26] , and whether these are differentially related to ADHD is of importance [27]. Finally it is important to assess whether any association exist independently of between-study variables (e.g. continent, diagnostic instrument used, and dimension of SES).

SES

SES refers to an individual's social and economic position, and has been defined as "A broad concept that refers to the placement of persons, families…with respect to the capacity to create or consume goods that are valued in our society" [28]. Socioeconomic disadvantage has been linked to a range of poor health outcomes throughout the lifespan. There is a large body of literature that highlights the gap in health between the most wealthy and poorest families that has been detected almost universally across societies [29-31]. Children, like adults from disadvantaged backgrounds, are at increased risk of a range of poor outcomes due

to socioeconomic disadvantage, including childhood and adolescent mental health disorders [30, 32] as well as increased mortality and a range of other illnesses across the world [20]. Poor mental health in childhood is itself associated with a range of negative consequences in adulthood, including premature mortality [33] and continued mental health problems [30]. These children are more likely to have lower educational achievement than their peers [5], problems with cognitive and behavioural development [34] and an increased risk of comorbid mental health conditions [30].

The current review systematically evaluates whether a socioeconomically disadvantaged background is associated with a diagnosis of (or risk of) ADHD. This review aims to clarify the strength of the association between ADHD and socioeconomic disadvantage, and to see whether this link, if it exists, is robust across the multidimensional concept of SES.

Aims of the current study

The systematic review aims to address the following questions:

- Is there evidence for an independent association between ADHD (or hyperactive/inattentive profiles) and low SES?
- What size is this association by dimension of SES?
- Does this association exist independently of between-study variables (e.g. continent, diagnostic instrument used, dimension of SES)?

Methods

Protocol and Registration

The protocol for this review was registered with Prospero (CRD42013006160), a database for registration of systematic review protocols.

Eligibility criteria (inclusion/exclusion)

The population to be studied was not initially restricted by age or setting. This enabled screening to take place for any studies of children and adults with ADHD as long as SES during their childhood was reported, and for studies set within both community and clinical populations to be included. Included study designs were population surveys, and included cross-sectional, longitudinal and cohort studies. Case studies, editorials, reviews and opinions were excluded from the review. Dissertations and conference abstracts were also excluded. To be included, publications had to report on an association between ADHD/hyperkinetic disorder and SES in the family during the person's childhood. A validated diagnostic or dimensional measure of ADHD was required, for example Conners' Ratings scales, the Child Behaviour Checklist, a structured clinical interview (e.g. K-SADS-E or DISC), or parent report of a clinical diagnosis by a health professional. Studies where prescriptions were used as proxy for a diagnosis of ADHD were excluded, as medication for ADHD behaviours does not necessarily mean a clinical diagnosis has been given to the child, and due to differing healthcare systems and policies in different countries, medications are offered to or be accepted by different subgroups of children who may have been diagnosed with ADHD.

Accepted measures of individual-level SES included parental education, occupation, income and marital status. Studies were also included if the authors measured geographical or school-level SES, and provided sufficient information about the SES of the area was available. SES indices and measures were only included if details were available on the information that was used to calculate the index (e.g. the Hollingshead index is calculated using marital status, occupational prestige, educational attainment and employment /retirement status). Studies that compared 'urban' and 'rural' populations were not included unless more detailed socioeconomic information was also available. Non-English language articles were included

in the review, and translations were obtained for those studies based on their perceived relevance from an English language abstract. Publications from all countries were included on the condition that they had been published in a peer-reviewed journal or book.

Studies were included if they had been published during or from 1994, as this was the year of publication of the Diagnostic and Statistical Manual for Mental Disorders IV (DSM-IV) [2], which includes the widely used ADHD diagnostic criteria.

After initial screening, the authors decided to remove studies that had a majority of participants under the age of five, given that hyperactive behaviours are extremely common among very young children as a normal stage of development, and although some overactive toddlers will go on to be diagnosed with ADHD, the majority will not. Articles which used overlapping study samples were also excluded, for example different studies using data from the same cohort. In these cases, the study with the most reported detail on SES was included in the review, if this was comparable across studies the study with the largest sample size was included.

Information sources

Eight electronic databases were searched for relevant articles in October 2013. These were selected to cover several relevant disciplines such as education, health and psychology. The databases searched were ERIC (via ProQuest); Assia (via Proquest); CINAHL (via EBSCOhost); MEDLINE (via Ovid); PsycINFO (via EBSCOhost) ; Embase (via OvidSP); Social Policy and Practice (via Ovid) and PubMed. Forward and back-citation screening of included studies was conducted between December 2013 and February 2014 by two reviewers to identify additional articles to include in the review.

Search

The search strategy was empirically derived, based on principles developed by Hausner et al. [35]. The purpose of this strategy was to reduce subjectivity in development of the search. In brief, 38 directly relevant publications were selected based on one key paper which contained a selective review on the topic [8]. These were randomly divided into two sets; a development set (n=25) and a validation set (n=13). The development set was entered into a text frequency software package (PubReMiner [36]), and based upon the frequency of emerging key words a search strategy was developed using PubMed. Once this search was as streamlined as possible and yet correctly identified 24 out of 25 articles in the test set, it was tested against the validation set. The final search strategy (see Table 1,) could identify 37 out of the 38 relevant articles, and was then adapted for each database.

Study selection

Included studies were selected in a three-stage process. After the initial search and removal of duplicated results, titles and abstracts were screened by two reviewers. Articles were rated for suitability (see Figure 1). Two reviewers then examined the full text of the remaining articles. Translations were obtained for non-English articles, with one reviewer working with translators to determine whether the publication should be included in the final review. Studies were excluded if they did not provide sufficient detail of measures used for both ADHD and SES and if the article met any of the other exclusion criteria. For articles where a consensus could not be reached between the two reviewers, a third reviewer offered a final opinion. EndNote X5 [37] was used to manage the screening process.

Data collection process

Data was extracted from the included articles by the lead author, and a second reviewer extracted data from a random 10% of the included studies to ensure agreement.

Data Items

The following items were extracted from each publication: study design; population, age range, gender of participants, and country of study; setting; method of ADHD diagnosis and number of informants for the diagnosis; measures of SES (e.g. parental education, income, housing tenure); the level SES was measured at (e.g. family level, school, neighbourhood); and relevant findings. If the authors provided both unadjusted and adjusted analyses, note was taken of the impact this had on findings and the variables authors adjusted for.

Risk of bias

Quality assessment items were also extracted from included papers. Quality assessment questions were derived from the Newcastle-Ottawa scale, which was specifically adapted for the current study after advice from the Evidence Synthesis Team at the University of Exeter Medical School. The quality items used were:

- Did the authors report psychometric details of the ADHD measure they used?
- Is the cohort representative with minimal potential for selection bias?
- Do the authors report on the number of informants for diagnostic measures and state whether they included impairment/multiple setting criteria in their assessment of ADHD?
- Is detail of drop-outs and missing data provided?
- Do the authors report adjusted analyses regarding SES and ADHD?

- Are the SES measures used robust (do the authors clearly define what was measured and how)?

Synthesis of results

Random effects meta-analyses were carried out where subgroups of studies were suitably comparable, i.e. studies measured SES in the same way with similar study design and reported results in such a form as to allow calculations of odds ratios (ORs) and 95% confidence intervals for meta-analysis of the data. Meta-analysis results are reported by an overall effect size (OR)), with 95% confidence intervals and their significance. I^2, a measure of heterogeneity, and prediction intervals (representing the likely range of odds ratios of studies across different settings) are also reported.

Due to the heterogeneity of included articles, statistical meta-analyses of the majority of studies were not possible. Instead, results were synthesised using a mainly narrative approach, with random-effects meta-analyses conducted in a sub-sample of the included studies, using Stata v13 [38].

Results

Study Selection

A total of 1369 electronic records were initially identified (see Figure 1). Screening of titles and abstracts reduced this to 218 publications for full text screening. After screening, 66 publications were found suitable for inclusion in the review. Of these 66 publications, 24 were removed due to overlapping samples, young age of participants or a combination of the

above. The final number of studies included in the review was 42, of which 15 provided data for the meta-analyses.

Study characteristics

Characteristics of included studies are summarised in Table 2. Studies were conducted in 22 countries on five continents. Eight studies had samples that were recruited at least in part through a clinical setting, and 34 utilised community samples, which were mainly population-based cohort or cross-sectional studies. Seven case-control studies were included in the review. Sample sizes varied from 53 to 842,830, with 25 of the 42 studies having a total sample of over 1,000 participants.

The age range of participants was 5-19 years. No studies that met inclusion criteria examined ADHD in participants over the age of 19 and reported on their SES at birth or during childhood. ADHD was diagnosed with varied clinical measures; information regarding diagnosis was given by parents, teachers, in some cases the child themselves, and clinicians/researchers. Most studies reported using information from one or two informants to make a diagnosis of ADHD, six studies used more than two informants. Seven studies relied on parent report of a clinical diagnosis.

Of the included studies, SES dimensions measured included parental income, occupation, education, and single parent status. There was substantial heterogeneity both in measures of SES used across studies, as well as in the way that studies reported the associations. 27 of the included publications' primary aim was to examine early life or family correlates of ADHD

or child mental health problems. Five studies also measured variants of geographical level SES (e.g. SES of residential area, Index of Multiple Deprivation) and two studies measured school-level SES (e.g. private or government school attended) however as the majority measured individual-level SES variables these will be the focus of the results.

Risk of bias

The quality of included studies varied considerably. Table 3 details the quality of each study. Less than half the studies reported psychometric detail for the ADHD measures used, and only five explicitly reported that informants were asked to consider impairment in day-to-day life or across settings. The majority of studies used a representative sample; however six were open to selection bias i.e. by recruiting through clinical settings, parent support groups or reported minimal detail on recruitment and selection processes. Sample size varied substantially between studies, and several authors failed to report details of participant attrition or evaluate the impact of missing data. 12 of the 42 papers provided adjusted analyses: often the reason this was not included was because the association of interest to this review was not the primary aim of the individual study. SES measures were generally well reported, in that the measure used and how results were categorised was identified and reported clearly, with parent-reported income, education or marital status being the most frequently used measures. In contrast, one study measured SES by tuition paid to the school as a proxy for parental income. Another is unclear on whether the SES variables were reported by the child to the researchers or by their parent.

Results of individual studies

Due to the heterogeneity of measures used, statistical combination of all study results were not possible. Results of individual studies are presented in Table 4. There was heterogeneity within study results regarding whether an association was found, and what measure of SES this was found for. Syntheses of findings are described below according to dimension of SES and overall.

Results of studies by dimension of SES

Mother Education

Six studies were sufficiently homogenous in their methodology to be synthesised in a meta-analysis to examine the effect of mothers' education on ADHD risk (Figure 2a). The pooled odds ratio (OR) is 1.91 (95% CI 1.21-3.03, p=0.006, I^2 =91%), demonstrating that on average in the included studies, children of a mother with no educational qualifications or high school qualifications only were almost twice as likely to have ADHD than children of mothers who are highly educated. The 95% prediction interval is 0.37-9.75, indicating that in spite of this evidence, statistical confidence in there being a robust association beyond the studies included in the meta-analysis is limited.

An additional 17 studies investigated this association but were not suitable for inclusion in the meta-analysis due to wide variation in the recording of educational attainment, e.g. many studies divide education into 'high' or 'low' based on years spent in full time education, but the boundary of division varied by study. Eight of these were in agreement with the pooled effect size from the meta-analysis, with estimates for effect sizes including OR 2.64 (95% CI

1.43-4.88) [39], OR 2.28 (95% CI 1.97-2.63) [40], to OR 1.30 (95% CI 1.23-1.37) [41]. Two studies reported associations for a subtype of ADHD only; One study reported an OR of 1.31 (95% CI 1.02-1.70), representing a slightly increased risk in children of mothers who left school before age 17 for the combined subtype of ADHD [42] and another found an increased risk of low maternal education only for the inattentive subtype of ADHD (t(800) =-.39, p=0.001) [43]. Seven studies did not find any association between maternal education and offspring ADHD.

Father Education

Six studies explicitly explored the association of fathers' educational level on child's risk for ADHD. Three of these were suitable for meta-analysis and generated a pooled OR of 2.10 (95% CI 1.27-3.47, p=0.004, I^2 =86%), indicating that on average in these studies, children of fathers who had none or few qualifications were more than twice as likely to have ADHD than their peers (Figure 2b). This estimate is slightly larger than that for mothers' education. Due to the small number of studies in this meta-analysis, we could not calculate a prediction interval.

Of the three studies unsuitable for pooled analysis due to differing measures of education level, two report strong agreement with the meta-analysis results. One reports lower father education levels in their ADHD group (OR 2.3 95% CI 1.9-2.7) [44], and another reports a strikingly similar effect size (OR 2.27 95% CI 1.96-2.62) [40].

Single Parent Families

Ten studies provided data for a meta-analysis of the unadjusted effect of living in a single parent family on a child's risk of ADHD. The pooled effect size OR 1.85 (95% CI 1.64-2.08, $p<0.001$ $I^2 = 46\%$), demonstrates that on average across the included studies, children living with single parents were 1.85 times more likely to have ADHD than their peers in two-parent families. The 95% prediction interval for this meta-analysis is 1.42-2.42, indicating that for 95% of similar studies conducted, an effect size between 1.42 and 2.42 will be found, adding weight to the estimate. The results from the study by Duric and Elgen [44] stand out; this lack of association may have been due to their sample, which consisted of 187 children who were referred to a child and adolescent mental health clinic for suspected ADHD, with the control group being those who did not meet ICD-10 criteria on assessment.

Six studies provided results from adjusted analyses exploring single parent families as a risk factor for ADHD. The magnitude of the effect size reduced from that of the unadjusted analysis; however the adjusted results do support the finding from this (pooled OR 1.28, 95% CI 1.08-1.52, $p=0.005$, $I^2 =0\%$), the 95% prediction interval is 1.00-1.63. There does not appear to be a pattern in which variables were adjusted for with the change in results, however one study appeared to be driving the overall effect, which remained statistically significant. The authors adjusted for socioeconomic factors as well as other demographic variables, and have over 68,000 children in their sample [41].

Six studies did not contribute data to the above meta-analyses for single parent status [43, 45-49], often because the authors did not distinguish between single parent families and cohabiting/ unmarried families with two parents. One reported a non-significant association between single parent families and ADHD [48]. Another also reported no association;

although using symptom scores as a continuous measure they did find slightly higher average scores for children of single mothers [45]. Khamis [43] found a significant association between marital status (χ^2 (1,773)=5.78, p=0.01) and ADHD combined type, finding a higher proportion of unmarried parent(s) of children with combined type ADHD as compared with their peers with married parents, although this association was not significant for the inattentive and hyperactive-impulsive subtypes.

Index of SES

We meta-analysed results from the four studies that used an index of SES divided in to three bands: high, middle and low, comparing the risk of a child having ADHD if their parents were classed as low SES as opposed to high. The pooled effect size was larger than that seen for the other SES measures (OR 2.21 95% CI 1.33-3.66 p=.002, I^2 =83%), indicating that on average children of families classed as low SES were 2.21 times as likely to have ADHD than their high SES peers (Figure 4). The 95% prediction interval is 0.22-22.13, which indicates that we currently have insufficient data to be confident in the true size of the association.

An additional ten studies used an index measure of SES, but were not suitable for meta-analysis because of use of continuous measures or a score-based SES measure, or insufficient data. One study reported an OR of 1.29 (95% CI 1.15-1.45), indicating that children with ADHD were 1.29 times more likely than their peers to have low SES [19]. Similarly, others found higher prevalence rates of ADHD in children of low SES (7.3% prevalence in the low SES group, 5.1% in the middle SES group and 2.9% in the high SES group; χ^2 =13.28, p<0.001) [50], the same trend was reported by a further study [51], who found a dose-

response gradient of SES and ADHD prevalence (low SES 21.3%, medium 20.8% and high SES 10.7%), although this pattern was not replicated using repeating the analysis with children who have an IQ over 80. Ornoy [52] also reported a difference in ADHD prevalence by SES, with those of low SES having an ADHD prevalence of 12.62% and those of average SES 5.13%. The large variety in prevalence rates is likely to reflect differing ADHD measures and potentially geographic variation between studies; In a German sample, DSM-IV prevalence is reported [50]; in Colombia a DSM symptom questionnaire was used in conjunction with the Conners' scale [51], and Ornoy [52] utilised the Conners' questionnaire with a cut-off point of 21 and over in an Israeli sample. Using the Duncan Socioeconomic Index, one study found no significant difference of SES between children with and without ADHD [53], similarly one study did not find an association between Index of Multiple Deprivation (IMD) and hyperactivity [54], however two studies found an association between low SES and ADHD [55, 56].

Occupation

Three studies explored the association between parental occupation and ADHD, however due to the variation between studies in types of occupation assessed, the way these were categorised, and reporting of results it was not possible to synthesise the data in a meta-analysis. One study found no association between occupational class (divided into 6 categories) and ADHD [57]; similarly another reported finding no association between occupational class of fathers (divided into three categories) and ADHD in their child, although they did report that mothers' who reported being a housewife as opposed to working were more likely to have a child with ADHD (OR 2.85, 95% CI 2.02-4.03, $p<.001$) [58]. Another study found that children with hyperactivity problems were more likely to have

parents in the skilled (OR 1.53 95% CI 1.28-1.83) and unskilled (OR 1.93 95% CI 1.52-2.45) occupational classes than the professional occupational class [59].

Income

Due to the wide variety of measures used for income it was not possible to meta-analyse the results from studies. This was partly due to between-country differences, i.e. differences in currency, minimum wage and poverty lines, as well as relative living costs, and partly due to the lack of standardisation of measures of income e.g. of those studies using US dollars as their metric, one study [60] measured monthly income in 3 bands: >$2740, $1370-$2740 and <$1370 whereas others use continuous measures of annual income, either in increments of varying values or not [46, 61]. Others dichotomise into 'low' and 'high' income, based on cut-offs of wages or percentage of the nation's poverty line, or used the current minimum wage or quintiles based on responses to define categories. Statistical combination of these widely varying measures would be inaccurate as they are not estimating the same quantity in a statistical sense.

Of the studies exploring the association between income and ADHD, 15 found significantly increased risk of ADHD for those in the lowest income band of each study. These ranged from an OR of 4.51 (95% CI 2.58-7.88) with a metric based on minimum wage [62] to 1.33 (95% CI 1.17-1.51) for a study using a cut-off of 200% of the poverty line [41]. Several studies however found that confidence intervals for the effect size overlapped 1, in spite of having an odds ratio in the same direction. For example one study [49] reported an OR of 2.50 (95% CI 0.87-7.18), breaking income into five bands. Only one study reported an OR below 1, although this was not statistically significant [63]. Overall the vast majority of the studies exploring income found an association between low family income and child ADHD,

although of the studies which adjusted for other variables the majority find that this association is no longer significant [19, 41, 57, 63]. This may be because the factors that studies adjusted for lie on the causal pathway between ADHD and SES, (for example, parent mental health) and several of these studies adjusted for other dimensions of SES, which may themselves be more strongly associated with ADHD than income.

Synthesis of results

35 of the 42 articles reported a significant association between a measure of socioeconomic disadvantage and increased risk of ADHD at the 5% level. Only six studies found no association between ADHD and low SES, and one U.S. study reported a significant association between ADHD and socio-economic advantage [64], these authors used an area-based median income measure which may not be indicative of the SES of the individual child's family.

Studies that accounted for other factors such as gender and comorbid mental disorders had mixed results, in that for some the SES-ADHD association remained [e.g.24] and for others it did not [e.g. 64]. There was little overlap between the types of variables adjusted for between studies.

Of the studies that could be meta-analysed, effect sizes for the association between socioeconomic disadvantage and ADHD ranged from OR 1.28 (95% CI 1.08-1.52) for the adjusted single parent analysis, but of those not restricted to adjusted analyses from OR 1.85 (95% CI 1.64-2.09) for single parent families to OR 2.21 (95% CI 1.33-3.67) for the index of SES. We calculated prediction intervals in response to the high heterogeneity (I^2) in the meta-analyses, and these demonstrate that more, similarly designed studies are needed to establish

a robust association for the domains of education and index of SES, although the prediction interval for the meta-analysis of single parent status implies this association will remain robust.

Associations by continent

There was a clear skew with included publications more likely to originate from Europe (n=15) or North America (n=12) rather than Asia (n=6), South America (n=7) or Australia (n-2). No included publications were based in Africa. However, statistically significant results are distributed between the continents and there are no cases where studies from one continent find no significant associations between ADHD and low SES, suggesting that the association is indeed universal. Overall, significant associations were found on half or more of the occasions studied; Australian studies found significant results in 6/7 SES-ADHD associations studied, USA-based studies found significant results on 17/22 occasions, European studies 20/30, Asian studies 8/15 and South American studies found significant results on 5/11 instances.

Discussion

Summary of Evidence

This review is the first to systematically evaluate evidence of associations between socioeconomic disadvantage and ADHD. Studies from across five continents contributed to the review, and conclusions drawn are relevant in many different countries. The review found evidence to support claims that socioeconomic disadvantage is indeed associated with an increased prevalence of ADHD in children.

One major finding of the review was the striking lack of homogeneity between study methodologies, which hampered the extent to which findings could be pooled. Studies measured various combinations of parental income, education, occupation, index of SES and marital status in order to represent SES, and there was little consistency between studies in how these disparate variables were estimated. There is a strong theoretical argument that different aspects of SES represent different but overlapping concepts. These different aspects may have differential associations with the outcome when examining child development [65]. Because many of the included articles reported different aspects of SES and their data separately, we have synthesised the results by SES measure. Although there are arguments for pooling the facets of SES and attempting to generate an overall estimate of the effect size of the SES-ADHD association, the heterogeneity of variables and the way that they have been measured would result in reporting an effect size that would be potentially misleading and not methodologically robust. However, the consistent association of a wide-range of variables, measured using disparate methods suggest that each aspect of socioeconomic disadvantage confers an increased risk of ADHD in children.

Children from families whose mothers (or fathers) have few educational qualifications are on average 1.91 (95% CI 1.21-3.03) times more likely to have ADHD or have more symptoms of ADHD than their peers with highly educated mothers, and this although there is less evidence, the same magnitude of effect was found for father's educational attainment. Similarly, we found that children of single parents are 1.85 (95% CI 1.64-2.08) times more likely to have ADHD than children in families with two parents. The magnitude of the increased risks for education and marital status overlap, although because they are measuring different things they cannot be said to mean the same thing. Studies using an index of SES (using a composite score of different facets of SES), estimate the increased odds to be slightly

higher than for the other individual aspects; with a child in a low SES family being on average 2.21 (95% CI 1.33 3.66) times more likely to have ADHD than their high SES peers. Whether this higher figure is of theoretical significance we cannot be sure, but it may represent an additive risk of different SES dimensions; with those in families that are disadvantaged across the board being at even higher risk of ADHD than those who are "low SES" in only one dimension. Cumulative risk models or emergent risk models may therefore be relevant to the aetiology of ADHD, and there is a comprehensive overview of using these models in child development research and outline recommendations for future practice [66].

Child Mental Health

How do our findings regarding ADHD compare to risks conferred by low SES for other childhood mental health outcomes? A narrative review of studies examining the link between socioeconomic disadvantage child mental health (which they divided between internalising and externalising disorders) concludes that low SES increases the risk of child mental health problems by 1.18-3.34 times, which was reflected in the author's reporting of the overall differing prevalence of mental disorder by SES group: with low SES having a prevalence of 13.2% whilst high SES is 8.9% [30]. The authors recommend systematic examination of individual mental health disorders and their association with SES: we have answered this call. Other systematic reviews exploring child mental health have examined the association between SES and depressed mood or anxiety in 10-15 year olds and concluded that young people in low SES families were 2.49 times (95% CI 2.33-2.67) more likely than higher SES youth to have these symptoms [67]. Similarly, others have found a small but reliable association between lower SES and antisocial behaviour [68]. On the other hand, not all childhood neurodevelopmental disorders are clearly associated with socio-economic disadvantage; for

example, US studies have found autism is more prevalent in high SES groups [69]. Our findings, in contrast, suggest the association between SES and ADHD may follow the same pattern seen in a wide range of other childhood mental health outcomes where low SES confers a small but significant risk.

Putative Mechanisms

This review has established evidence that ADHD in childhood is associated with socio-economic disadvantage in children's families. The key question raised by this work surrounds the mechanisms through which this association acts. Many studies in our review adjusted for potentially confounding or explanatory variables, and on adjustment, the number of studies finding an association between low SES and ADHD was substantially reduced. This suggests that these factors lay on the causal pathway or acted as confounders in the relationship. Factors adjusted for by studies in this review that accounted for part of the SES-ADHD association include parental mental health, suboptimal health behaviours during pregnancy, and child comorbidities.

Unfortunately, there is little or no overlap between these other factors across studies, and so we are no closer to uncovering the precise mechanisms by which SES is linked with ADHD. Previous research has shown that socioeconomic disadvantage is highly correlated with a large variety of outcomes and behaviours that may be relevant to the causal mechanisms of ADHD. For example, smoking during pregnancy is associated with both socioeconomic disadvantage and ADHD, although this seems to be an unlikely causal factor as demonstrated both by genetically informed study designs [70], and that, similar to SES, once other factors

are adjusted for the association is no longer significant [71]. Parenting behaviours are another hypothesised causal mechanism for ADHD; Ellis and Nigg [72] report that aspects of parenting are associated with child ADHD over and above the impact of parental ADHD symptoms. There is evidence that those of low SES are less likely to be actively engaged parents, spending less time on child rearing than high SES parents, due perhaps lack of resources in the family environment [73]. The association of early psychosocial risk with ADHD has perhaps been under-appreciated.

Other factors that also display a socioeconomic gradient have been hypothesised to be associated with ADHD; for example bullying and SES [74], with victims of bullying and those who bully and are victims both being more likely to come from a low SES household, and children with ADHD are more likely to be bullied or bullies themselves [75]. Diet may also be a mediator, for example, a randomised, double-blinded, placebo-controlled, crossover trial found artificial colours or a preservative (or both) in the diet result in increased hyperactivity in 3-year-old and 8/9-year-old children in the general population [14].

It has been argued that severe family disadvantage has a role in the aetiology of ADHD, and this has implications for the nosology of the condition [76]. Webb suggests there may be two types of ADHD, one primarily caused by genetic predisposition, and the second ‘phenocopy’ ADHD which may result from early experiences of violence and abuse. She maintains such experiences make children hyper-vigilant and these symptoms are easily mistaken for true ADHD [76]. This is a similar phenomenon to ‘quasi-autism’ seen in severely neglected Romanian orphans [77]. Could the ADHD-SES association observed in this review be driven by this extreme ‘quasi ADHD’ where symptoms of severe deprivation mimic those of

ADHD? Future research could examine the strength and nature of the ADHD-SES association in socio-economic gradients that exclude the most deprived families.

Heritability

ADHD is known to have substantial heritable components, and the mechanisms by which ADHD and low SES may be transmitted between generations may overlap. This is illustrate d in a paper on health inequalities that aims to bring together the social causation and social selection theoretical approaches into an interactionist model of how socioeconomic inequalities impact on development [26]. This kind of model could be applied to ADHD; e.g. those with psychological illness are more at risk for being socioeconomically disadvantaged [21], and so their children are brought up in a disadvantaged environment, which in turn makes them more vulnerable to psychological difficulties [30]. Children with ADHD are more likely to leave school at an early age and have lower educational attainment [78], and therefore be considered low SES, and their children are likely to have inherited genetic traits for ADHD.

Direction of effect

In addition, a child with ADHD may elicit changes in the family environment, for example the stress of parenting a child with ADHD may lead to conflict between parents, resulting in separation or divorce and thus being classed as low SES, or the demands of the child may lead to a parent giving up their job in order to be able to spend more time caring for them, again likely leading to a decrease in SES [19]. These effects are unlikely to occur in isolation, and they are more likely to be a complex web of circular and interrelated associations [26].

Future work should use longitudinal, genetically informed designs in order to tease apart the relative impacts of each SES-ADHD mechanism, and the direction/s it operates in. It is especially important to disentangle to what extent the SES-ADHD relationship observed is driven by predisposition to ADHD inherited from parents with poor SES outcomes. Adoption and surrogacy designs are well suited for this, as are second-generation birth cohort studies i.e. longitudinal birth cohorts where the original intake of children now are adults and have children themselves.

Methodological Heterogeneity

The lack of cohesion in the methodologies of included studies has limited the ability of this review to expound on the strength of the association between SES and ADHD. Data harmonisation initiatives such as the CLOSER programme (www.closer.ac.uk) have specific remits to maximise the use and comparability of data across cohort and longitudinal studies. Authors conducting work that explores socioeconomic concepts should adhere to guidelines or best practices for data comparability, and many studies included in our review would have benefitted from more transparent reporting of results. However, the varied measures and methodologies included in this review lend weight to our findings, and in spite of substantial heterogeneity between studies, the majority found similar magnitudes of association, and when meta-analyses were possible, the findings of studies using similar measures and methodology consistently demonstrated the increased risk of ADHD with socioeconomic disadvantage.

The results of this review clearly emphasise the need for researchers to use homogenous measures of SES across studies. The lack of consistency in measures of SES is a hindrance both to clinicians' and policy makers' understanding of this association with ADHD and impacts on their ability to make informed decisions.

Other findings

A further aim of this review was to examine whether the ADHD-SES association differs by continent. In spite of the large number of countries and continents covered by included publications, results by continent were as mixed as those overall. This does however suggest that findings across continents do not differ. Further work could explore within and between-country variations in SES and prevalence of ADHD in more depth.

The largest study in the review was the only one to find a significant association in the opposite direction from that expected [64]. The authors' used area-level median income as their measure for SES, and used child health clinic records to examine ADHD cases, however those of higher socioeconomic status are more likely to access healthcare services, which may have influenced these results. Results from the current review suggest that area level SES may either account for some of the association found, for example Ford, Goodman and Meltzer [57] did not find a significant ADHD-family SES association but only reported results that had adjusted for school and neighbourhood disadvantage. Future studies would benefit from measuring both family and school/neighbourhood indicators of SES, as negative effects of low SES in one realm of a child's life may be ameliorated by higher SES in other

areas, or indeed risk of ADHD may be greater for children who are exposed to socioeconomic disadvantage in more than one area of their lives.

Limitations

The study of an association such as that between socioeconomic disadvantage and ADHD is impossible to measure in a controlled experimental manner. Instead, evidence is in the form of observational cohort, cross-sectional or case control studies. These studies are inherently different from each other due to different sampling strategies, definitions of ADHD and what is considered as representing SES, and so are difficult to combine in a systematic manner. Due to the heterogeneity of studies included in the review, meta-analysis was only possible for a small sub-sample of studies which were sufficiently similar in design and measure to combine results. In addition, reporting of results was poor in some studies, with information that would be needed for meta-analysis not reported. There was varying quality in individual studies, both in terms of strengths and flaws. Some were open to selection bias, some had very small samples and those which had sufficiently large samples may have only measured one or two indicators of SES.

This review excluded seven studies (at full text screening, more were excluded prior to this) where prescription of stimulants was used as a proxy for ADHD diagnosis. This was due to concern over selection bias in individual studies, especially in countries without free healthcare such as the USA. However, this also meant excluding potentially important studies from Scandinavian countries, where national databases and records are used to link detailed information about children and families, allowing for strong conclusions to be drawn due to

the large sample sizes in countries with social insurance and accessible services [79]. Although not included in this review, the Scandinavian literature generally supports our conclusions: for example Swedish children prescribed stimulant medication are more likely to hail from socioeconomically deprived backgrounds [80]. Other studies that may have contributed data were excluded due to not using a validated measure of ADHD.

Summary

An association between disadvantaged parental socioeconomic status (SES) and an increased risk of childhood attention deficit/hyperactivity disorder (ADHD) is commonly noted but is seldom the primary focus of research. The current review systematically evaluated whether a parental socioeconomic disadvantage is associated with a diagnosis, or increased risk of a diagnosis of ADHD, the size of this association, and whether this association varies by continent or developmental stage. Eight databases were searched for peer-reviewed articles that reported both on childhood diagnoses of ADHD and measures of family or neighbourhood SES. Articles were screened by two independent raters for inclusion suitability, forward and back citations of included publications were also hand searched. 838 articles were initially identified, of which 42 publications met inclusion criteria.

The current review has shown that there is increasing evidence for an association between socioeconomic disadvantage and ADHD, suggesting socio-economic disadvantage may lie on a causal pathway between, or may be caused by, ADHD genotype and phenotype. The association was only partially explained by other variables such as parental mental health, parental smoking behaviour and neighbourhood level deprivation. The strength of this association varies substantially between studies. These mixed results likely represent other causal or risk factors for ADHD which are themselves more prevalent in families who are

socioeconomically disadvantaged. Further research with a primary aim of investigating this association in more depth and looking into the possible mechanisms, and at different levels of SES is needed.

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Tables and Figure titles/legends in order from text

Table 1: Search strategy used in Medline

	PubMed/Medline Search Term	Type of term
	Attention Deficit Disorder with Hyperactivity/diagnosis	MeSH
AND	Socioeconomic Factors	MeSH
AND	ADHD or hyperactive*	title/abstract
AND	Socioeconomic* or advers* or poverty or income	title/abstract
AND	Epidemiology* or prevalen*	title/abstract

Note: MeSH- Medical Subject Heading

Figure 1: PRISMA flow diagram

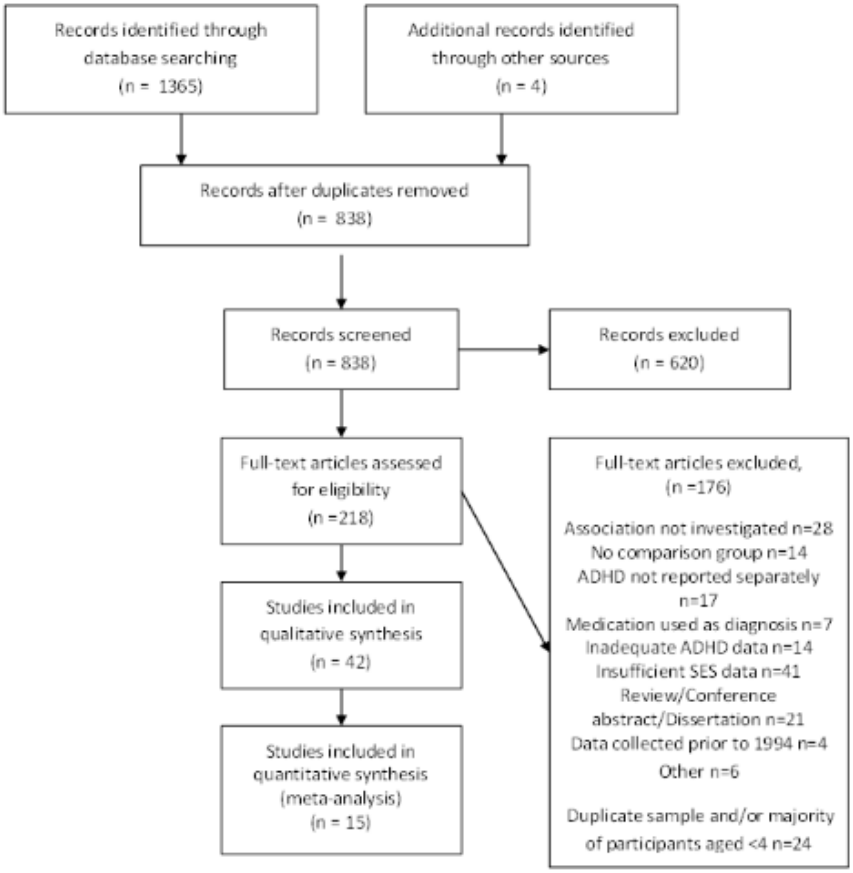

Table 2: Characteristics of included studies

Continent	First Author	Year	Design	Total Sample	Total with ADHD	Setting	Age	ADHD	SES measures
Europe	Andres	1999	CR	387	23	COM	10	K-SADS	Idx
	Ford	2004	CR	10438	139	COM	5 to 15	DAWBA	I, E, O, SP
	Franz	2003	CR	5178	N/R	COM	5 to 7	CBCL	SP
	Kotimaa	2003	CO	9357	808	COM	8	Rutter B2	O, SP
	Ornoy	2003	CC	160	30-34	COM	6 to 12	Pollack-Tapar and Conners	Idx
	Khamis	2006	CR	1000	345	COM	12 to 16	DSM interview	I, E, SP
	De Ridder	2007	CC	537	537	CLIN	av 11	Parent report of diagnosis/belong to ADHD support group	I, E, SP
	Dopfner	2008	CR	2452	123	COM	7 to 17	German ADHD rating scale	Idx
	P'Olak	2009	CR	2230	347	COM	10 to 12	CBCL, YSR, TCP	Idx
	Flouri	2010	CR	801	N/R	COM	11 to 16	SDQ	Idx
	Duric	2011	CR	494	96	CLIN	11.5 (SD 3)	ICD-10, clinican assessment, questionnaires	E, SP
	Boe	2012	CR	5781	N/R	COM	11 to 13	SDQ	I, E
	Apouey	2013	CO	78541	N/R	COM	4 to 17	Parent report of diagnosis	I
	Russell	2013	CO	13305	200	COM	7.2 (SD 0.2)	Parent report of diagnosis	I, E, SP, Idx
	Kvist	2013	CO	172299	2457	COM	4 to 10?	ICD-10 code in psychiatric register	I, E
USA	Scahill	1999	CR	449	89	COM	9.2 (1.78)	DISC and Conners'	I
	Biederman	2002	CC	522	280	COM/CLIN	6 to 17	Screening symptom questionnaire, K-SADS-E	Idx
	St Sauver	2004	CC	5701	305	COM	13 to 19	Clinical diagnosis and supporting questionnaire	E, SP
	Barry	2005	CR	215	N/R	CLIN	9 to 12	CBCL/TRF	Idx
	Counts	2005	CR	206	134	COM/CLIN	7 to 13	DISC and SNAP	Idx
	Schneider	2006	CR	up to 9278	433	COM	~8	Parent report of diagnosis	I, E, SP
	Visser	2007	CR	79264	6183	COM	4 to 17	Parent report of diagnosis	I, E, SP
	Roberts	2009	CR	4175	50	COM	11 to 17	DISC	I

	Wagner	2009	CR	748	N/R	COM	7 to 8	DISC/HBQ/CBQ	I, E
	Lingenini	2012	CR	68634	7137	COM	5 to 17	Parent report of diagnosis	I, E, SP
	Getahun	2013	E	842830	39200	COM	5 to 11	CBCL, clinical interview and ICD criteria	I
	Sagiv	2013	CO	604	~75	COM	8	Conners'	I, E, SP
Australsia	Graetz	2001	CR	3597	268	COM	6 to 17	DISC- not crit D or E	I, E, SP
	Sciberras	2011	CO	3474	64	COM	6 to 7	SDQ, parent report of diagnosis	I, E, SP
Asia	Lee	2008	CC	109	50	COM	7 to 10	DSM diagnosis by clinician	E
	Al Hamed	2008	CR	1287	208	COM	6 to 13	ADDES and parent questionnaire	E, O, Idx
	Bener	2008	CR	1869	208	COM	6 to 12	Conners'	I, E
	Yoshimasu	2009	CC	360	90	COM/CLIN	6 to 15	Clinical diagnosis and questionnaires	I, E, SP
	Li	2009	CR	20152	853	COM	9 (SD 1.5~)	Parent report of diagnosis	I, E, SP
	Siddique	2011	CC	1819	130	COM	9 to 17	DSM-IV criteria and questionnaires	Idx
South America	Cornejo	2005	CR	460	94	COM	4 to 17	Conners', DSM-IV symptom checklist	Idx
	Montiel-Nava	2005	CC	53	29	CLIN	4 to 13	Conners', DISC	Idx
	Bauermeister	2007	CR	1896 & 763	142 and 200	COM/CLIN	4 to 17	DISC	E, SP, Idx
	Pastura	2009	CC	304	26	COM	9 to 14	SNAP and PChIPS	I, E
	Anselmi	2010	CO	4423	880	COM	11	SDQ	I
	de la Barra	2013	CR	1558	156	COM	4 to 18	DISC	SP
	Pires	2013	CR	370	49	COM	6 to 13	CBCL and TRF	E

Notes: Design: CR- cross sectional CO- cohort CC- case control E-Ecologic, Setting: COM- community setting CLIN- clinical setting, SES measure: I-income E- education O-occupation SP-single parent Idx- index.

Table 3: Quality of included studies

First Author	Year	Psychometric detail for ADHD measure?	Selection bias? Cohort representative?	Report no of informants?	Impairment/ Impact criteria?	Sample size with ADHD	Details of drop out/missing data provided?	Adjusted analysis provided for SES and ADHD?	Robust SES measure?
Scahill	1999	+	++	+	-	+	++	-	++
Andres	1999	N/R	++	-	-	+	++	-	+
Graetz	2001	++	++	+	+	++	++	-	++
Biederman	2002	N/R	++	+	-	++	-	-	++
Ornoy	2003	N/R	-	+	-	+	-	-	+
Kotimaa	2003	++	++	+	-	+++	++	-	+
Franz	2003	++	++	+	-	N/R	++	-	+
Ford	2004	+	++	+	-	++	++	+	++
St Sauver	2004	N/R	++	+	-	++	U	+	++
Barry	2005	++	+	+	-	N/R	++	+	++
Counts	2005	N/R	+	+	-	++	++	+	+
Cornejo	2005	N/R	++	+	-	+	U	-	++
Montiel-Nava	2005	N/R	-	+	-	+	++	-	-
Khamis	2006	N/R	++	+	-	++	++	-	++
Schneider	2006	N/R	++	+	-	++	++	-	+
Visser	2007	N/R	++	+	-	++++	-	-	++
Bauermeister	2007	+	++	+	+	++	++	+	++
de Ridder	2007	N/R	-	+	-	+++	++	-	++
Dopfner	2008	N/R	++	+	+	++	++	-	++
Lee	2008	N/R	+	+	-	+	-	-	++
Al Hamed	2008	N/R	++	+	-	+++	++	-	+
P'Olak	2009	++	++	+	-	++	++	-	++
Li	2009	N/R	++	+	-	+++	++	-	++
Wagner	2009	++	++	+	-	N/R	++	+	++
Pastura	2009	++	++	+	-	+	++	-	++
Roberts	2009	N/R	++	+	-	++	++	-	++
Yoshimasu	2009	N/R	-	+	-	+	++	-	++
Bener	2009	N/R	++	+	-	++	++	-	+
Anselmi	2010	++	++	+	-	+++	++	+	++
Flouri	2010	++	++	+	-	N/R	++	-	+
Siddique	2011	N/R	-	+	-	++	++	+	++
Sciberras	2011	+	+	+	+	+	++	+	++
Duric	2011	N/R	-	+	-	+	U	-	++
Apouey	2011	N/R	++	+	-	N/R	-	-	++
Boe	2012	++	++	+	+	N/R	++	+	+
Lingenini	2012	N/R	++	+	-	+++	++	+	+
Russell	2013	N/R	++	+	-	++	++	+	++

Sagiv	2013	++	++	+	-	+	++	+	++
de la Barra	2013	++	++	+	+	++	++	-	++
Kvist	2013	++	++	+	-	++++	N/A	-	+
Pires	2013	N/R	++	+	-	+	++	-	+
Getahun	2013	N/R	+	+	-	++++	N/A	-	+

Notes: ++ good, + adequate, - risk of bias, U unclear, N/R not reported, N/A not applicable. Sample size (n with ADHD): + <100 ++ 100-500 +++ 500-1000 ++++ >1000

Table 4: Results of individual studies

	Study Characteristics						Results by SES measure				
	First Author	**Year**	**Country**	**Total N**	**Design**	**Setting**	**Income**	**Education**	**Occupation**	**Single Parent**	**Index of SES**
Europe	Andres	1999	Spain	387	CR	COM					**
	Ford	2004	UK	10438	CR	COM	-	-	-	-	
	Franz	2003	Germany	5178	CR	COM				-	
	Kotimaa	2003	Finland	9357	CO	COM			*	**	
	Ornoy	2003	Israel	160	CC	COM					**
	Khamis	2006	Israel	1000	CR	COM	*	*		*	
	De Ridder	2007	Belgium	537	CC	CLIN	-	-			
	Dopfner	2008	Germany	2452	CR	COM					**
	P'Olak	2009	Netherlands	2230	CR	COM					**
	Flouri	2010	UK	801	CR	COM					-
	Duric	2011	Norway	494	CR	CLIN		**		-	
	Boe	2012	Norway	5781	CR	COM	**	**			
	Apouey	2013	UK	78541	CO	COM	**				
	Russell	2013	UK	13305	CO	COM	*	*		*	*
	Kvist	2013	Denmark	172299	CO	COM	**	*		**	

USA	Scahill	1999	USA	449	CR	COM	**				
	Biederman	2002	USA	522	CC	COM/CLIN					**
	St Sauver	2004	USA	5701	CC	COM		*		-	
	Barry	2005	USA	215	CR	CLIN					**
	Counts	2005	USA	206	CR	COM/CLIN					*
	Schneider	2006	USA	up to 9278	CR	COM	**	-		**	
	Visser	2007	USA	79264	CR	COM	*	-		**	
	Roberts	2009	USA	4175	CR	COM	-				
	Wagner	2009	USA	748	CR	COM	**	**			
	Lingenini	2012	USA	68634	CR	COM	*	**		**	
	Getahun	2013	USA	842830	E	COM	--				
	Sagiv	2013	USA	604	CO	COM	*	**		*	
Aus	Graetz	2001	Australia	3597	CR	COM	*	*	*	*	
	Sciberras	2011	Australia	3474	CO	COM	-	*		*	
Asia	Lee	2008	South Korea	109	CC	COM		-			
	Al Hamed	2008	Saudi Arabia	1287	CR	COM		*	*		*
	Bener	2008	Qatar	1869	CR	COM	**	-	-	-	
	Yoshimasu	2009	Japan	360	CC	COM/CLIN	-	-		**	

	Li	2009	China	20152	CR	COM	**	**		**	
	Siddique	2011	India	1819	CC	COM					*
South America	Cornejo	2005	Colombia	460	CR	COM					*
	Montiel-Nava	2005	Venezuela	53	CC	CLIN					-
	Bauermeister	2007	Puerto Rico	1896 and 763 [a]	CR	COM/CLIN		-		-	*
	Pastura	2009	Brazil	304	CC	COM	-	-			
	Anselmi	2010	Brazil	4423	CO	COM	**				
	de la Barra	2013	Chile	1558	CR	COM				*	-
	Pires	2013	Brazil	370	CR	COM		**			
	no studies						22	23	5	19	15
	total N of all studies by measure of SES						1322062	401501	26548	408458	27351

Notes: Aus= Australia. CR=cross sectional CO= cohort CC= case control COM=community CLIN=clinical ** significant in adjusted model at p<0.05, * significant in unadjusted model at p<0.05 ,– not significant, a inattentive subtype b combined subtype c this study found a significant association between increasing income and risk of ADHD d hyperactive/impulsive subtype e ADHD significantly more likely if the child's mother is a housewife rather than employed. Father occupation was non-significant (NS) f significant for those in group whose perception of poverty was "live poorly" as compared with "living well". "Living paycheck-paycheck" was NS

Figure 2: 2a Meta-analysis of association between mother education and offspring ADHD. 2b : Meta-analysis of association between father education and offspring ADHD

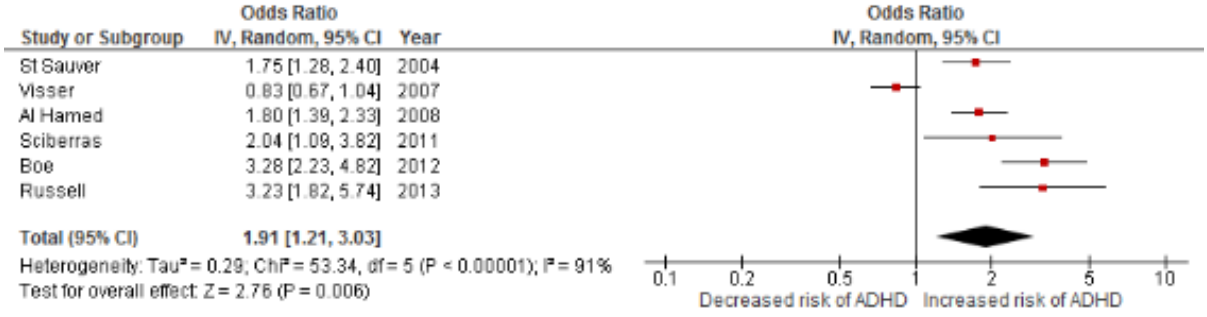

Figure 2a Notes: N's for each study; St Sauver- 5701; Visser- 79264; Al Hamed- 1287; Sciberras- 3474; Boe- 5781; Russell- 13305

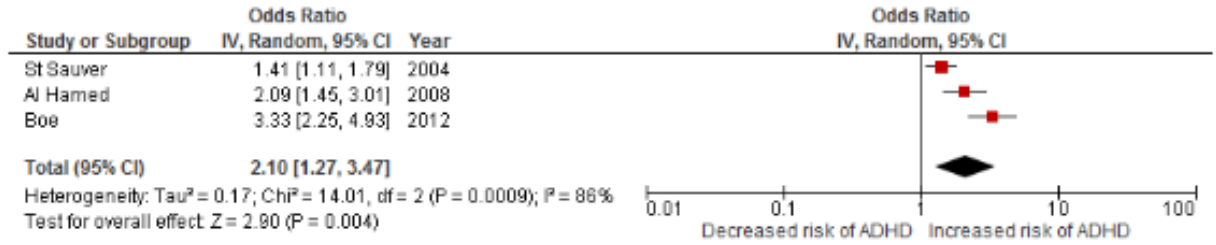

Figure 2b Notes: N's for each study; St Sauver-5701; Al Hamed- 1287; Boe- 5781

Figure 3: 3a: Meta-analysis of association between single parent families and offspring ADHD (unadjusted studies) 3b: Meta-analysis of association between single parent families and offspring ADHD (adjusted studies)

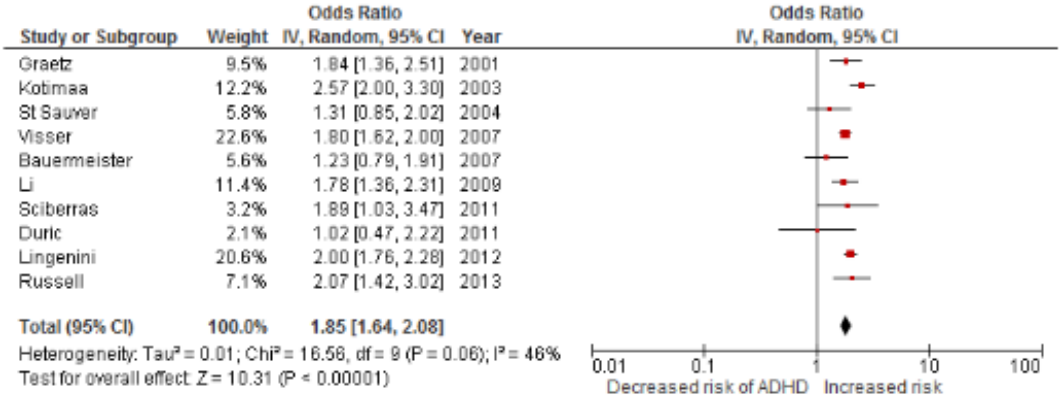

Figure 3a Notes: N's for each study; Graetz-3597 ; Kotimaa-9357 ; St Sauver- 5701; Bauermeister-1896; Visser- 79264; Li-20152 ; Sciberras- 3474; Duric-494 ; Lingenini-68634 ; Russell 13305

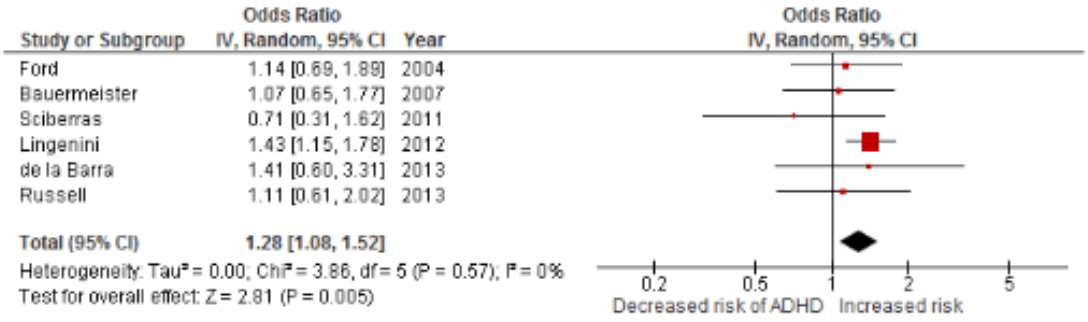

Figure 3b Notes: Adjusted for- Ford: age, gender, general health, neurodevelopmental disorder, intelligence, reading, housing tenure, number of significant life events, family functioning, parent mental health, mother's age when child born, maternal educational qualifications, school disadvantage, Carstairs index of neighbourhood deprivation, anxiety disorder, depression, oppositional defiant disorder and conduct disorder. Bauermeister: number of disorders other than ADHD. Sciberras: maternal smoking during pregnancy, maternal alcohol use during pregnancy, maternal post-natal depression, intensive care at birth, birth weight, household income, maternal age at child birth, number of people in the household, primary caregiver education, marital status and male gender. Lingenini: BMI, sex, age,

depression, anxiety, race/ethnicity, poverty, family members' smoking status, highest level of education in household, healthcare coverage, participation in sports and in clubs, average computer use on a weekday. De la Barra: age, family psychopathology, school dropout, perception of functional family, maltreatment, sexual abuse. Russell: parent and teacher strengths and difficulties questionnaire hyperactivity and impact subscales. N's for each study: Ford-10438 ; Bauermeister- 1896; Sciberras- 3474; Lingenini- 68634; de la Barra-1558 ; Russell- 13305

Figure 4. Meta-analysis of association between Index of SES and offspring ADHD

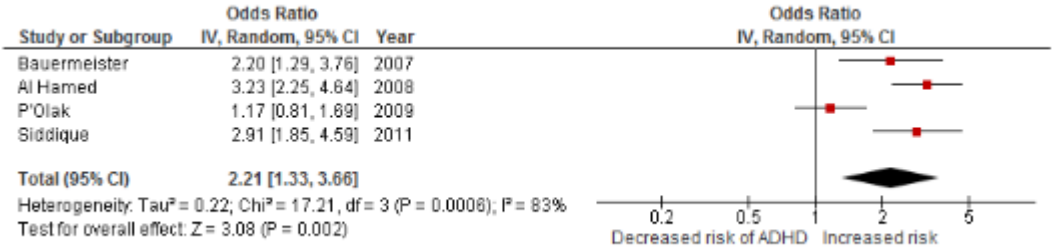

Figure 4 Notes: Bauermeister- used poverty perception as measure of SES; Al Hamed used a score based on fathers' education, occupation and income; P'Olak used a composite score of family income, and both parents' education and occupational level; Siddique used housing tenure, material possessions, education, occupation and income. N's for each study: Bauermeister- 1896; Al Hamed- 1287; P'Olak- 2230; Siddique- 1819